NETWORKING: The Basics of Local Area Networks
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There are 840,000+ lawyers in America, and as many as one-third of them know very little about PCs or how to use them in the practice of law. They have let the PC revolution pass them by, for the most part believing they can survive to retirement without them. Surprisingly, even those lawyers who do use PCs are unwilling to take the next step—connecting PCs together to

NETWORKING
The Basics of Local Area Networks

form a local area network or LAN. This article is intended to demystify LAN technology and to explain how the components of a LAN are easily connected to form an efficient file-sharing environment.

The Benefits of Networking

If you want to save time and money and communicate better by sending and receiving electronic messages to and from office colleagues, networking provides the solution. LANs conserve time and allow files to be shared with others on the network. They also permit high-speed, high-resolution printers, CD-ROM drives, scanners, and other electronic devices to be shared. Further, running software applications such as word processing, telecommunications, and time and billing software, on a network, can

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save you money in the long term compared to installing individual copies of software on each office PC. And the savings can be considerable.

Convenience also is an important advantage. For many, having the ability to send messages back and forth electronically across a LAN is justification enough for installing a network.

Components of a LAN

All LANS have at least three components: (1) cabling, (2) network adapter cards, and (3) network operating software. In planning for a LAN, you must first consider whether to construct a Peer-to-Peer or a Client-Server network.

Peer-to-Peer. A Peer-to-Peer network is usually limited in size. It is decentralized and used to connect 2-10 workstations. By decentralized I mean that each workstation is an independent PC that can be used to communicate with other PCs on the LAN. No single PC or workstation is in control of the network. Rather than adding a dominant central computer to control the flow of information, each PC is responsible for maintaining communications with all other PCs on the network. In a Peer-to-Peer network a user's applications, programs, and files are stored on the hard drive of his or her own personal workstation. If desired and agreed, the contents of the user's hard drive can be shared with other network workstations. Thus, others on the network may have access to the programs and files resident on any given networked PC. In a Peer-to-Peer network, authorized network users may share a high-speed printer; CD-ROM drive; or scanner attached to a PC. Exchanging e-mail messages is easily done as well.

The main advantages of Peer-to-Peer networking are (1) low price, (2) decentralized structure, and (3) ease of use and maintenance. The hardware is inexpensive and PCs can be added or removed by simply connecting or disconnecting cables. These networks are perfect for small law offices or home use. The operating system software needed to run them includes Microsoft's Windows for Workgroups 3.11 and Windows 95 (both of which are already installed on millions of IBM PCs and clones), and a competitive product called LANtastic.

Client-Server. If you project the need to connect more than ten PCs or will be installing large databases, large accounting programs, or video applications, then Client-Server technology which requires a different kind of operating system, should be used. A Client-Server network, like Peer-to-Peer, consists of PCs or workstations that are interconnected. But instead of using each workstation's decentralized hard drive to access local programs and files, a high-end computer called a "file server" is employed to store programs and data centrally and to smooth the distribution of information among workstations on the network. For large networks, additional file servers may be used. One server could store programs and data while another might hold law firm billing and accounting information.

Each PC or workstation in the network is known as a "client". Communication among clients is indirect. Information is first sent to the file server where it is stored until network resources are sufficient to route the data to the required destination. The file server acts as a router, monitor, and traffic officer, efficiently and rapidly

moving data from place to place along the network. Applications, programs, and data that need to be accessed widely and regularly, are stored on the file server's hard drive. If desired a user may store personal files on his or her workstation's local hard drive.

The main advantage of Client-Server networking is its ability to change rapidly as computing needs vary, though hardware and software costs are considerably more expensive for Client-Server net-

working than they are for Peer-to-Peer. Not only must a high-speed server(s) be purchased but the software needed to run the network is more costly as well. Windows NT, Novell NetWare, and Unix are among the more popular choices.

To install an appropriate LAN the user must know his or her current needs and be able to estimate the likelihood of future expansion. If 2-10 computers is all that will be needed then a Peer-to-Peer network, the simplest and least

expensive to install, will work fine. For ten or more computers the more costly and more complex Client-Server network should be installed.

The Ethernet Standard

Just as telegraphy required a standard code in order to communicate over distances and Morse code became the language of choice, so too was a standard or protocol needed to assure that cabling manufacturers, adapter card manufac-

INSTALLATION TIPS FOR THE DO-IT-YOURSELFER

Should you desire to install and configure your own LAN, here are a few additional tips.

For a backbone topology:
• Use a thin coax cable for networks of three-to-four computers. Thin coax is reliable because it is encased in a sheath or outer surface that guards against interference. However, since the maximum length of a cable is limited to roughly 900 feet, one computer must be within 900 feet of the next.
• Affix a metal T-connector to each workstation in order to accept both an incoming and outgoing cable. Connect the incoming cable to one side of the T-connector and the outgoing cable to the other side. This will construct a backbone or spine of cabling where the T-connectors provide input to and output from each PC on the network.
• Pay special attention to the first and last PCs. At each end of the spine there will be a PC with a T-connector having only one cable attached. For example, the first PC on the network

will have a cable connecting it to the second PC. Thus, the first and last PCs' T-connectors will have unused ends. It is essential that you plug each end with a 50-ohm terminator in order for the network to operate. Failing to do so will result in an unsuccessful installation. The backbone must have two terminators, one at the beginning and one at the end of the network.

For a star topology:
• Use 10BaseT cabling (also known as "twisted pair" cabling) if you plan to expand to more than three or four workstations or if you must run cables through hard to reach areas like ceiling plenums, into adjacent offices. Twisted pair or 10BaseT cable resembles telephone wire. It is slightly larger than thin coax and has eight wires instead of two or four. The cable ends have RJ-45 connectors which look like telephone connectors but are larger. One end plugs into the hub and the other connects to the workstation.
• When using 10BaseT cabling you *must* use a hub. The network

will not work without it. Whether it is used in a Peer-to-Peer or Client-Server network the hubs associated with 10BaseT cabling have built-in error correction and auto-partitioning features that help reduce network traffic errors and increase overall network performance.
• 10BaseT cabling is available in different grades. Use category 3, which is a thin grade, for your home or a small law office. You can use category 5, the highest grade, in any network. However, you *must* use category 5 if you are using Fast Ethernet, which speeds up traffic along the network tenfold. The Ethernet standard limits 10BaseT cabling to approximately 300 feet, but if cabling needs to be longer a "repeater" that boosts the signal can be used.

Configuring the network adaptor card:
• Configuring a network adapter card to work in your system is a two-step process. Generally, the manufacturer of the card provides software to make this process easier.

turers, and network operating software developers would provide products that worked synchronously with each other. The Ethernet standard was the choice. Ethernet is a set of rules that prescribes how network technology should work. The rules were developed by the IEEE (Institute of Electrical and Electronic Engineers). It is a board comprised of university, corporate, and government members. The Ethernet standard provides a formula for hardware and software manufac-

turers to apply in making their products. There are other networking standards like Token Ring and ARCnet, but Ethernet is by far the most popular and least expensive.

Cabling and Topology
Though workstations can be connected with specialized wireless hardware they are more often than not connected with cabling. The precise way in which the cabling is arranged or laid out is referred to as the cabling's topology. The Ethernet standard allows for three different kinds of topologies—backbone, star, and mixed.

Backbone topology. The term "backbone" derives from the way in which some networks are arranged all in a row. A single strand of cable runs from one PC to the next connecting one to another. You can purchase kits that include all of the hardware and software (with the exception of the network operating system) needed to build this type of network, at local computer retail outlets. The cost of a two computer backbone network kit is approximately $75.

Star topology. This topology refers to a network that resembles a starfish in design. The outer extremities or "arms" terminate at workstations. Each workstation has a cable connection to a central core called a "hub," which is the medium through which all network traffic flows.

The hub is simply a box with ports or holes that resemble phone jacks. Cabling extends from each PC to the hub. Most hubs are "dumb" which means that all you need to do is plug in the cables and the hub will monitor the traffic and correct potential corruption of data.

The cost of a two computer star topology kit, including the hub, network adapter card, power supply and cables is approximately $110.

Mixed topology. This configuration is a hybrid of the other two. Groups of star topology networks, each with a central hub, may be connected to each other using backbone cabling. Special hubs are arranged along the backbone to connect to the workstations.

Network Adapter Cards
After the topology or cabling plan has been decided and the network cable installed, the cables must be connected to each PC or workstation. This is the primary purpose of the network adapter card. Whether the topology is backbone or star, every PC must have an adapter card in order to be connected to the network.

The Ethernet standard requires adapter cards to transmit and receive data at 10 million bits per second. Since one byte of information is the equivalent of one keyboard character and each byte consists of 8 bits, the 10 million bit per second transfer rate means that 1.25 million characters will travel across a standard Ethernet network each second.

Choosing an Adapter Card
No two PC designs are the same. For starters, 386, 486, and Pentium class machines differ architecturally from each other. What's more, earlier and later 486 machines differ in design. Some have expansion slots that take ISA (Industry Standards Association) 16-bit cards while later model motherboards have PCI (Peripheral Component Interconnect) 32-bit expansion slots. Selecting the proper network adapter card is determined by the expansion slot present on your motherboard. The network kits mentioned earlier are grouped according to type of expansion slot. Don't buy a 16-bit model if you have an available 32-bit slot. The 32-bit bus transfers data twice as fast as the 16-bit.

• To determine whether your PC has 16-bit or 32-bit slots, turn the computer off, touch a metal portion of the cabinet to discharge static electricity, open the case, and look at the motherboard. 16-bit buses are black in color and are more numerous than 32-bit buses which are white.
• First, the card must be assigned an "interrupt" which interrupts the computer and alerts it to the need to process network traffic. Second, an input/output address or memory address must be assigned. The input/output address is the area of a computer's random access memory (RAM) used to store network data. The software packaged with the adapter card will guide you through the configuration process.
In general:
• You should select the topology (star, backbone, or mixed) of your LAN based on the number of workstations to be connected and the difficulty of setting up connections in hard to reach areas.

Network Operating System Software

The choice of network operating software is determined by the type of network that you install—Peer-to-Peer or Client-Server. The network cannot operate without network operating software. This software controls and manages communication between a workstation's hard drive and the rest of the network. The software handles e-mail, printing, disk activities, and more. Windows for Workgroups 3.11, Windows 95, and LANtastic each provide the software needed to run a Peer-to-Peer network. They are easy to configure and use. If the choice of cabling is a backbone topology the entire installation of a two computer network including cabling, installing the network adapter card, and configuring the software will take half an hour or so to complete. Installation of these components in a star topology, depending on the difficulty of running cable to hard to reach areas, will take a bit more time.

A medium to large network can include from ten to many hundreds and even thousands of workstations. The software needed to transmit high volumes of network traffic at high speed is quite different from software needed to run a Peer-to-Peer network. Windows NT, Novell NetWare, and Unix operating systems are designed specifically for Client-Server environments.

Conclusion

Unlike purchasing PCs, where it is wise to buy for today, not for tomorrow—the opposite principle applies in networking. You should invest for the future when purchasing a networking system. If you can be absolutely certain that you will not require more than ten workstations and will not need to install any special application software, a Peer-to Peer network will be more than adequate to meet your needs. If, however, you project a need for more than ten workstations and/or the installation of special application software, a Client-Server network is advisable. This alternative gives you the greatest amount of flexibility because adding workstations to the network is as easy as adding another hub with corresponding cables. ∎

Frederic S. Baum is a computer education specialist who teaches attorneys how computers work and how to use them in the practice of law. Mr. Baum has served on the faculty of the Benjamin N. Cardozo School of Law, Yeshiva University and as Director of the Library of the Association of the Bar of the City of New York, where he also served as Co-chair of the Task Force on Technology and the Practice of Law.

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